ratio $\frac{\alpha}{1+\alpha} = 0{\cdot}32$, and instead of obtaining equality when the photometer is adjusted for this value the difference is most marked.

The effect has also been shown by obtaining two photographs on the one plate; one photograph being the result of an exposure to the light from two fluorescing cubes one behind the other, and the second photograph the result of superposing the effect of the light from A alone, when fluorescing, upon that from B after having passed through A, when the latter was not fluorescing. The exposure in each of the three cases being the same, a very distinct difference is shown in the result; the superposed photographs being always the darker in the negative, notwithstanding the fact that the resultant effect of superposing two photographs due to light of the same intensity, or nearly so, has been found not to be equal to but less than that due to light of double the intensity acting for half the time. If the resultant effect were equal to the sum of the separate ones, the effect caused by the change of absorption would have been still more marked.

In the determinations of α and β a null method has been employed by which any appreciable want of uniformity in the illumination can be detected.

The source of illumination has been almost invariably the spark discharge of a Leyden jar between cadmium electrodes, being one of the richest sources of the fluorescence-exciting rays, and the photometer one specially constructed for the purpose.

"On the Theory of the Magneto-Optic Phenomena of Iron, Nickel, and Cobalt." By J. G. LEATHEM, B.A., Fellow of St. John's College, Cambridge. Communicated by Sir ROBERT S. BALL, F.R.S. Received May 11,—Read June 17, 1897.

(Abstract.)

In Mr. Larmor's Brit. Assoc. Report (1893) on the Action of Magnetism on Light, it is pointed out (§ 20) that there are two ways in which the magnetic field may affect the phenomena of light propagation, and two corresponding types of magneto-optic theory. It is the object of the present paper to take the fundamental equations of the second type of theory in a general form on the lines of Mr. Larmor's recent papers on Electrodynamics, and to develop them so as to obtain the solutions of the problems of magnetic reflection and of transmission through magnetised films; the formulæ so obtained are compared with the available experimental results, and the agreement of the theory with experiment thus put to the test.

2. The notation is nearly the same as Maxwell's, (P, Q, R), (u, v, w), (a, b, c), and K, having their usual significations; σ is specific conductivity, and c the velocity of radiation; (f'', g'', h'') corresponds to Maxwell's total electric displacement, and has components (f, g, h) and (f', g', h'), of which the former is the displacement involved in the ether strain, and the latter that involved in the polarisation of the matter. It being as usual assumed that for light oscillations the effective magnetic permeability is unity, the fundamental equations of the theory are as follows:—

(i) The two circuital relations,

$$\frac{dc}{dy}-\frac{db}{dz}=4\pi u \quad \text{and} \quad \frac{d\mathrm{R}}{dy}-\frac{d\mathrm{Q}}{dz}=-\frac{da}{dt}.$$

(ii) The equations of the current,

$$u=\sigma\mathrm{P}+g_3\mathrm{Q}-g_2\mathrm{R}+df''/dt,$$

where the vector (g_1, g_2, g_3) represents the Hall effect.

(iii) The displacement relations, and the elastic relations between electromotive force and the corresponding polarisation, viz.,

$$f''=f+f', \qquad f=\mathrm{P}/4\pi\mathrm{c}^2,$$

and

$$f'=\frac{\mathrm{K}-1}{4\pi\mathrm{c}^2}\mathrm{P}+b_3\frac{d\mathrm{Q}}{dt}-b_2\frac{d\mathrm{R}}{dt},$$

the vector (b_1, b_2, b_3) representing, in transparent matter, the whole magneto-optic effect.

3. The equations of propagation are found in the usual way, (u, v, w) being taken as independent variables. In them and in the boundary conditions (b_1, b_2, b_3) and (g_1, g_2, g_3) appear only as the vector, $\left\{\left(b_1\frac{d^2}{dt^2}+g_1\right), \left(b_2\frac{d^2}{dt^2}+g_2\right), \left(b_3\frac{d^2}{dt^2}+g_3\right)\right\}$, which is assumed equal to $\mathrm{C}_0e^{\iota x}(\alpha_0, \beta_0, \gamma_0)$, where $(\alpha_0, \beta_0, \gamma_0)$ is the intensity of magnetisation; $\mathrm{C}_0e^{\iota x}$ is thus the single magneto-optic constant of the theory.

4. The principal experiments which have been used to test the theory are those of Drs. Sissingh and Zeeman on magnetic reflection, their observations being measurements of the phase m and amplitude μ of the "magneto-optic component" of the reflected light, for various angles of incidence. It is noteworthy that the value of m derived from the theory involves x, but not C_0; while the theoretical value of μ is proportional to C_0, but does not involve x: this circumstance makes the test a severe one.

5. The following table will serve to indicate what sort of agreement is found to exist between the theory and the experiments.

Equatorial Reflection from Iron.

Angle of incidence.	Observed value of m.	Calculated value of m.
86° 0′	209° 26′	272° 35′ $-x$
82° 30′	204° 22′	265° 19′ $-x$
76° 30′	194° 49′	256° 31′ $-x$
71° 25′	190° 3′	251° 13′ $-x$
61° 30′	181° 49′	244° 18′ $-x$
51° 22′	179° 0′	239° 48′ $-x$
36° 10′	174° 9′	235° 27′ $-x$

If we suppose that the value of x is about 62°, the agreement shewn is remarkably good. Experiments on polar reflection from iron point to almost exactly the same value for x.

If we suppose the value of C_0 to be given by

$$-C_0 = 7{\cdot}283 \times 10^{-11},$$

the ratios of the calculated to the observed values of μ for the above angles of incidence are found to be respectively 1·13, 0·96, 0·99, 0·97, 1·01, 1·03, and 0·97; so that in the case of the amplitudes also there is good agreement.

6. For nickel the agreement of theory with experiment, though not so exact as in the case of iron, is still very good. The values indicated for the constants are

$$x = 76° \text{ to } 80°, \qquad -C_0 = 9{\cdot}225 \times 10^{-12}.$$

The agreement is better for cobalt, being specially good in the amplitude experiments. For polar reflection at incidences of 45°, 60°, and 73°, the ratios of the calculated to the observed values of μ are found to be 0·98, 0·97, and 1·07 respectively. The values indicated for the constants are

$$x = 64°, \qquad -C_0 = 1{\cdot}227 \times 10^{-10}.$$

7. The theory gives a satisfactory account of a phenomenon which has only recently been discovered, namely an effect of the component of magnetisation perpendicular to the plane of incidence. The change of phase which measures this effect has been observed by Zeeman, who, in a particular case, found it to be $0{\cdot}003 \times 90°$, with a mean error of $0{\cdot}001 \times 90°$. The value indicated by the theory is $0{\cdot}00243 \times 90°$.

8. Two of the many available experiments on transmission through magnetised metallic films are used to test the theory. In one of these the rotation observed by Lobach is 1·62°, while the value indicated by the theory is 0·961°. In the other the rotation observed by

Drude is 4·25°, the theoretical value being 2·972°. When it is borne in mind that the value of the magneto-optic constant derived from reflection experiments has here been applied to test experiments on transmission through films, with results not only of the same order of magnitude, but identical within the limits of uncertainty of the intensity of magnetisation, the agreement must be considered as a very satisfactory vindication both of the theory and of the experiments.

9. It is to be noticed that, as b_1, b_2, b_3 are necessarily real, the imaginary part of $C_0 e^{\iota x}$ must be entirely accounted for by the Hall effect. Hence the present theory involves the supposition that the Hall effect is very much greater for exceedingly rapidly alternating currents than for steady ones. There is nothing unnatural in this supposition, which may be compared with the fact discovered by Maxwell, that the ordinary coefficients of conductivity are very much smaller in the optical circumstances.

"Magnetic Properties of Iron at High Temperatures." By J. HOPKINSON, D.Sc., F.R.S. Received June 10,—Read June 17, 1897.

The present note is for the purpose of correcting two points in my paper in the 'Philosophical Transactions,' A, vol. 180.

First.—I was of opinion that my experiments showed that heating iron above its critical point did not entirely destroy the effects of previous magnetisation. Recent experiments I have made do not confirm this opinion. I would therefore wish to *delete* the following sentences in which the matter is referred to, viz. :—Page 414, lines 12 and 13; the first paragraph on page 454; the first two lines on page 455; the first paragraph on page 457; and from the words "two things" on line 5 to the word "second" on the same page. Also in the 'Proceedings of the Royal Society,' vol. 45, page 321, strike out the two paragraphs at the top of the page.

Second.—I have since been unable to obtain so great recalescence with approximately pure iron as is shown in Curve XXXIX, and can only conclude that I must have been in error as to the composition of the sample examined. I therefore wish in the last paragraph of the paper to speak of the sample as of unknown composition; to strike out the words "This shows why soft iron apparently does not recalesce"; to substitute "this" for "the" and strike out "of the soft iron" in the last line.

I also take the opportunity of correcting an error in the joint paper of myself and Mr. Wilson, vol. 189, pages 109—136. *Delete* the four